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NTSB Investigation Hearing

Battery/Battery Charger Sub-system

Panel 3 – Qualification and Safety

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Roles & Responsibilities re: Development & Qualification Testing

BATTERY

- ✓ Development testing
- ✓ Qualification testing
- ✓ GS YUASA

BATTERY CHARGER (BCU)

- ✓ Development testing
- ✓ Qualification testing
- ✓ Securaplane

BATTERY/BATTERY CHARGER Sub-System

- ✓ Development testing
- ✓ Qualification testing
- ✓ TAES

Qualification Test Plan and Procedures reviewed and approved by Boeing

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Qualification Processes for Battery and Battery Charger

Qualification Processes

- ✓ FAA conformity inspections completed on all qualification test articles and setups.
- ✓ All tests were witnessed by Boeing

TAES Qualification Role and Responsibilities

- ✓ TAES checked and validated GS YUASA / Securaplane qualification documents (QTP, QTR, analysis, …) and submitted to Boeing for approval.
- ✓ Battery/Charger Sub-System tested in order to support Boeing's application for aircraft certification.

TAES submitted qualification documents to Boeing as part of Boeing's application for Certification to FAA/EASA

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Development & Qualification Testing for Battery

Development Tests

- ✓ Cells Abuse Tests
- ✓ Cells Endurance Tests by GS YUASA and Boeing Phantom Works
- ✓ Battery FAA Foam Flame Test
- ✓ Battery Abuse Tests
- ✓ Battery Endurance Tests
- ✓ BMU Development Tests

Qualification Tests

- ✓ Functional tests
- ✓ Climatic tests
- ✓ Mechanical tests
- ✓ EMI/EMC tests
- ✓ Abuse tests

Development and all Qualification Tests were conducted by GS YUASA

Battery/BCU Sub-system Development and Qualification Testing

2006

✓ Development tests with Battery and Battery Charger were performed by Securaplane.

2006

✓ Development tests with Battery and Battery Charger were performed by GS YUASA.

2010

✓ Battery/BCU Sub-system functional Qualification tests were performed by TAES.

Sub-system functional Qualification Test Descriptions
Battery charge tests with actual Battery Charger
Battery discharge tests with actual Battery Charger
Battery/Battery Charger interface signals verification
Battery Failure simulation tests at sub-system level including : - overheat protection testing - over-voltage protection testing - over-discharge protection testing

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Safety Engineering Process

Standard used

✓ FAA Aircraft Guidance : Guidelines and methods of performing safety assessment on Civil Airborne Systems and Equipment
✓Boeing Standards and Industry Standards

Data Source

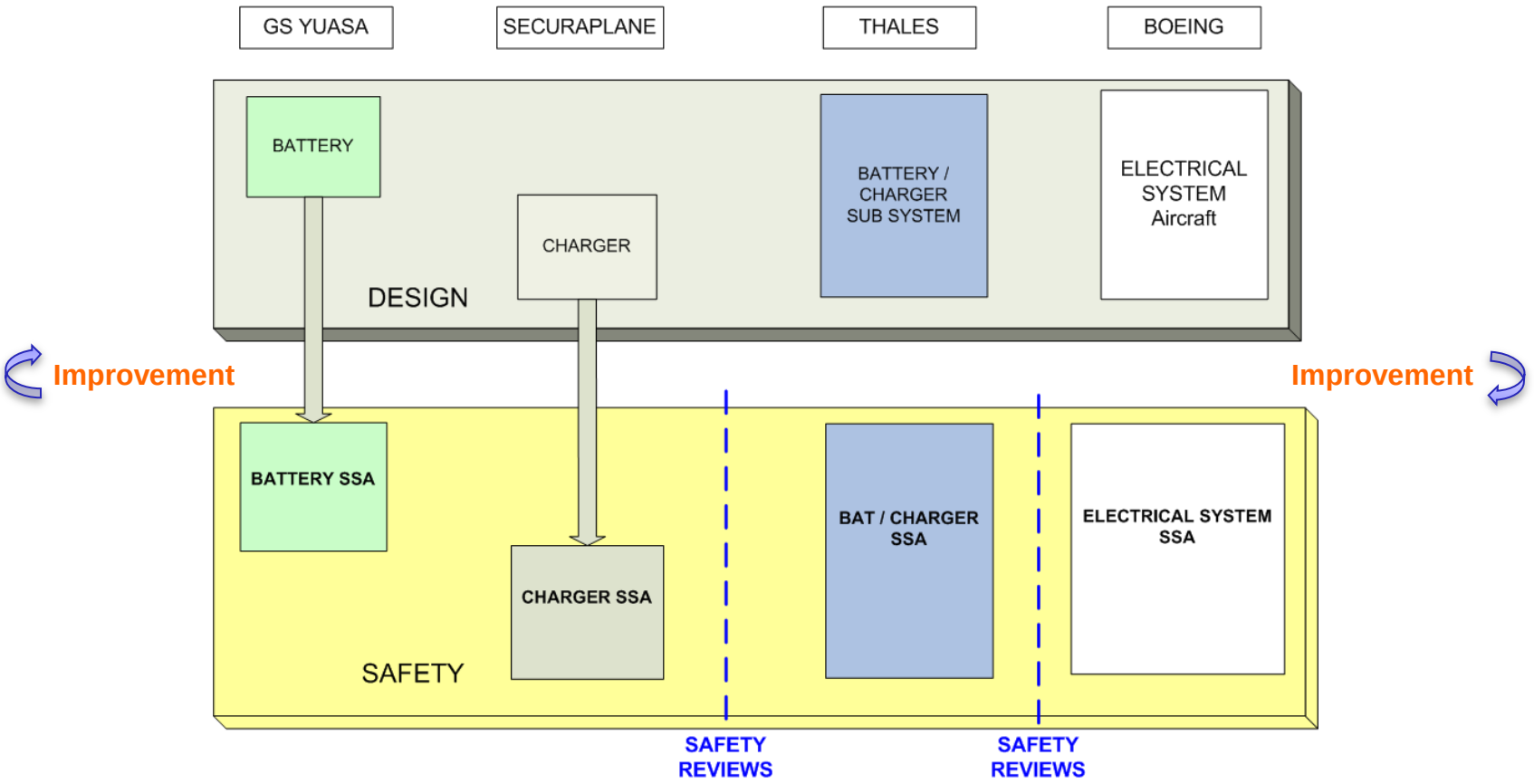
✓Field / Manufacturer experience
✓Prediction by computation of reliability models issued from standards

Process

✓Step 1: Functional Hazard Assessment (FHA)
✓Step 2: Fault Tree Analysis (FTA)
✓Step 3: Reliability, Failure Modes and Effects Analysis (FMEA)
✓Step 4: System Safety Assessment (SSA)

Safety Engineering Process

Iterative and Collaborative Process – Safety driven Design



Safety and Design Reviews involved all Parties

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Summary

- ✓ The entire safety engineering process was strictly followed according to FAA/EASA applicable guidelines and methods
- ✓ Iterative and Collaborative Process with GS YUASA, Securaplane and Boeing
- ✓ Every step of the process was safety driven
- ✓ All qualification tests were properly and successfully performed
- ✓ All the above was done according to Boeing's standards and with Boeing's approval

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